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Bivariate analysis of flood peaks and volumes using copulas. An application to the Danube River

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A multivariate analysis on flood variables such as flood peaks, volumes and durations, is essential for hydrotechnical projects design. A lot of authors have suggested the use of bivariate distributions for the frequency analysis of flood peaks and volumes due to the supposition that the marginal probability distribution type is the same for these variables. The application of Copulas, which are becoming gradually widespread, can overcome this constraint. The selection of the appropriate copula type/families is not extensively treated in the literature and it remains a challenge in copula analysis. In this study a bivariate copula analysis with the use of different copula families is carried out on the basis of flood peak and the corresponding volumes along a river. This bivariate analysis of flood peaks and volumes is based on streamflow daily data of a time-series more than 100 years from several gauged stations of the Danube River. The methodology applied using annual maximum flood peaks (AMF) with the independent annual maximum volumes of fixed durations at 5, 10, 15,20,25,30 and 60 days. The discharge-volume pairs correlation are examined using Kendall's tau correlation analysis. The copulas families that selected for the bivariate modeling of the extracted pairs discharge and volumes are the Archimedean, Extreme-value and other copula families. The evaluation of the copulas performance achieved with the use of scatterplots of the observed and bootstrapped simulated pairs and formal tests of goodness of fit. Suitability of copulas was statistically compared. Archimedean (e.g. Frank and Clayton) copulas revealed to be more capable for bivariate modeling of floods than the other examined copula families at the Danube River. Results showed in general that copulas are effective tools for bivariate modeling of the two study random variables.